2016

VCU Neuroguard: Multi-person Radiation Shielding Device

David Bauserman
Virginia Commonwealth University

Abigail Haines
Virginia Commonwealth University

Laynold Pilson
Virginia Commonwealth University

Madelaine Simmons
Virginia Commonwealth University

Team Members: David Bauserman, Abigail Haines, Laynold Pilson, Madelaine Simmons

Faculty Advisor: Dr. Rosa Marina Bilbao Y Leon, Dr. Jessika V Rojas Marin, Dr. Gary Tepper

Sponsor: VCU College of Medicine Neurosurgery Department

Sponsor Advisor: Dr. Lisa Feldman, Dr. John Reavey-Cantwell, Dr. Dennis Rivet

MECHANICAL AND NUCLEAR

VCU Neuroguard

Multi-person Radiation Shielding Device

CAPSTONE DESIGN EXPO 2016

Current Procedures

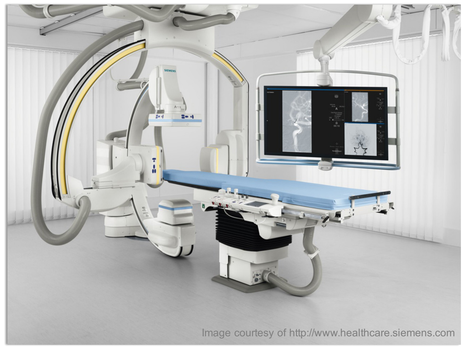


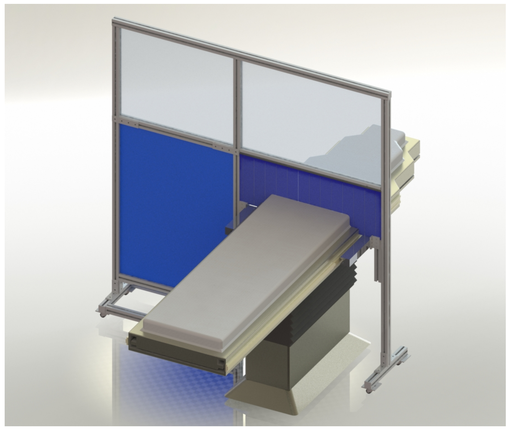
Image courtesy of http://www.healthcare.siemens.com

The Neurosurgery department at the Medical College of Virginia (MCV) utilizes a Siemens Artis Zee Bi-plane Fluoroscopic Imaging Device, seen above. The primary type of radiation shielding currently being used for this device is Personal Protective Equipment (PPE). This includes wearable lead aprons, lead thyroid shields, and leaded glasses. This PPE system is not ideal because it does not provide full-body shielding and can cause back pain as well as orthopedic injuries after long term use.

Customer Deliverables

- Shielding for all medical staff inside the “Safety Zone”
- High level of shielding that will negate the use of personal protective equipment
- Complete unrestricted access to the operative site
- To move in conjunction with the operating table
- Whole body, durable, and reliable x-ray shielding
- Protection that allows natural freedom of movement

The Design



VCU Neuroguard Prototype

The VCU Neuroguard has been specifically designed to fit the Artis Zee machine in MCV operating room 33. The constructed device is a prototype and does not include radiation shielding materials. The frame is comprised of 45-mm 80/20® aluminum extrusion. Clamps are used to affix the device to the table and linear bearings are used to allow for uninterrupted vertical movement of the operating table.

VCU Neuroguard Final Device

The final device will include leaded glass, flexible lead curtains, and a lead panel to provide the necessary radiation shielding. As can be seen in the image above, the translucent rectangular sections would be leaded glass. The large blue rectangular section to the left of the operating table would be the lead panel and hanging above the operating table would be the flexible lead curtains.

Shielding Calculations

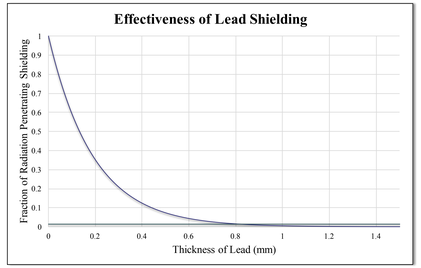
A required lead shielding thickness of 0.82mm was determined based off of the following parameters:

- an allowable dose limit of 0.02mGy/week
- a lead attenuation coefficient of 52.17 cm^{-1}
- machine settings of 109 kV and 3 mA

The intensity of the radiation that goes through the lead, I, is given by

$$I=I_0e^{-\mu t}$$

where: I_0 is the initial intensity, μ is the attenuation of the lead, and t is the thickness



Future Work

Since the current device is a prototype, there are a few things that need to make the device fully functional:

- Obtain radiation shielding material: lead panel, leaded glass, leaded curtain to complete device
- A permanent mechanism to attach device to table
- Adjust design to be used in other operating rooms